

HINGED BOTTOM COVER FOR UNHEADING A COKE DRUM

FIELD OF THE INVENTION

[0001] This invention relates to a coke drum, and more particularly, to a hinged bottom cover for unheading a coke drum.

5 BACKGROUND OF THE INVENTION

[0002] In a conventional delayed coking process, petroleum residues are fed at elevated temperatures to a large steel vessel called a coke drum, where the residues are thermally cracked and formed into coke. When the coke drum has filled with coke, the coke drum is injected with steam and cooled with water. To remove the coke from the coke drum, top
10 and bottom covers of the drum are removed in a process called unheading.

[0003] Since the coke drum must contain a severe atmosphere of elevated temperatures and high pressure, the bottom cover is typically secured to the coke drum by dozens of bolts that often must be loosened manually.

[0004] Reducing the labor involved in unheading is typically accomplished using remotely-
15 operated actuator systems. These systems are less labor-intensive since removing the bolts and cover can be automated.

[0005] However, actuator systems also have some drawbacks. For example, if the components of the system are welded to the coke drum, the welds may deteriorate over

time because of the high operating temperatures of the drum. Moreover, the weight of the contents of the drum, which the actuator system must handle, also adds a load to the actuator system, which it may not have been designed to withstand. A further drawback of existing systems is their lack of stability. When removing the massive cover, it is important that the head remain securely held throughout the unheading process. So far, no proposal has mitigated all these concerns.

[0006] One proposal is shown in U.S. Patent No. 5,098,524 to Antalffy et al. Antalffy et al. shows a coke drum unheading device in which the bottom cover remains attached to the coke drum throughout unheading. A bottom cover 27 is connected to the drum 1 by way of a pivot plate 35. A pair of hydraulic actuators 22 unhinges the bottom cover 27 from above. The drawback of this arrangement is that it attaches the pivot plate to the coke drum 1 itself. As a result, the weld holding the pivot plate 35 to the drum is exposed to the heat of the coke drum during coking, which reduces the life of the weld and therefore increases maintenance cost.

[0007] U.S. Patent No. 5,336,375 to Wallskog et al. attempts to remedy the weld problem by an embodiment shown in Figs. 5 and 6. As shown, the cylinders 162, 163 are attached to a removable support structure 180. Thus, the cylinders 162, 163 need not be welded to the coke drum. Nevertheless, the arrangement is less rigid than one in which the cylinders are attached to the coke drum itself, so cables 174 are needed to resist bending moments on the support structure 180. The drawback is that the support structure must withstand the additional weight of the coke drum and its contents as well as the large cables needed to

- 3 -

add strength to the support structure. This may shorten the life of the coke drum, or may be impossible to install in existing coke drums not designed for such stresses.

[0008] Another proposal is shown in U.S. Patent No. 5,500,094 to Fruchtbaum et al.

Fruchtbaum et al. shows a coke drum unheading device in which a bottom cover 12 has a protrusion 54. This protrusion 54 mates with notch 52 in a bearing plate 40. A hydraulic actuator 34 is carried on a car 22 and brings the bearing plate 40 up against the bottom cover 12. When the bolts holding the bottom cover 12 to the coke drum flange 14 are loosened, gravity presses the cover 12 against bearing plate 40. Although Fruchtbaum et al. does not attach any of the components to the drum, it does use a precarious system to remove the cover, reducing stability.

[0009] Each past proposal has its advantages, but the disadvantages of each indicate a need in the art for an actuator system that is not welded to the coke drum, is not supported by the drum, does not stress the coke drum with additional weight and will operate in low-clearance environments.

SUMMARY OF THE INVENTION

[0010] Our invention addresses the foregoing needs in the art by providing a hinged bottom cover for unheading a coke drum. The invention employs a vertical actuator and a rotating actuator, each of which is attached to a support structure at a support end and the bottom cover at a cover end. In addition, a frame assembly having opposing ends is provided. One end of the frame assembly is pivotally attached to the bottom cover and the other end is slidably mounted to the floor. The arrangement of the vertical and rotating actuators is

- 4 -

such that welds on the coke drum are avoided. Moreover, the bottom cover is securely held throughout the unheading operation.

5 [0011] In one aspect of the invention, the apparatus includes a support structure that supports at least the coke drum. A vertical actuator has a cover end attached to the bottom cover and a support end attached to the support structure, and is arranged to move the bottom cover vertically in a removal operation. A rotating actuator has a cover end attached to the bottom cover and a support end attached to the support structure, and is arranged to rotate the bottom cover in a removal operation. A frame assembly having opposing ends is provided, a pivoting end being attached to the bottom cover and a sliding end being slidably mounted. The frame assembly, the vertical actuator and the rotating actuator cooperate to remove the bottom cover in a removal operation.

10 [0012] In another aspect, the apparatus further includes a floor actuator attached to the sliding end of the frame assembly, the floor actuator and the frame assembly cooperating in order to remove the bottom cover only vertically.

15 [0013] In yet another aspect, the apparatus includes a connecting plate fixed to the bottom cover, and the pivoting end of the frame assembly is pivotally attached to the connecting plate.

20 [0014] In another aspect, the apparatus includes a floor attachment assembly. The floor attachment assembly includes an anchor attached to the floor and having a sidewall, the sidewall having an aperture. A slide block is also provided slidably disposed within the aperture of the sidewall. A pin interconnects the anchor and the sliding end of the frame

- 5 -

assembly, such that the slide block and the anchor slidably secure the frame assembly to the floor.

[0015] In another aspect, a method includes the steps of providing a support structure that supports at least the coke drum, providing a vertical actuator having a cover end attached to the bottom cover and a support end attached to the support structure. The vertical actuator is arranged to move the bottom cover vertically during a removal operation. The method also includes the steps of providing a rotating actuator having a cover end attached to the bottom cover and a support end attached to the support structure, providing a frame assembly having opposing ends so that a pivoting end is attached to the bottom cover and a sliding end is slidably mounted, and actuating the vertical actuator. In addition, the method includes sliding the sliding end of the frame assembly to move the bottom cover only vertically.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Fig. 1 shows a side view of a preferred embodiment of the invention with a bottom cover bolted to a coke drum during a coking process.

[0017] Fig. 1A shows a detail view showing a different feature of the invention.

[0018] Fig. 2 shows a plan view of the apparatus of Fig. 1.

[0019] Fig. 3 shows a side view of the apparatus of Fig. 1 with the bottom cover in the unbolted position and the cover lowered.

[0020] Fig. 4 shows a side view of the apparatus of Fig. 1 with the bottom cover in the position to remove coke from the coke drum.

- 6 -

[0021] Fig. 5 shows a view along view lines 5-5 in Fig. 2.

[0022] Figs. 6 and 7 show details of the floor attachment assembly.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

5 [0023] Fig. 1 shows an embodiment of the invention which is generally characterized by a plurality of actuators attached to a support structure and a bottom cover of a coke drum, as well as a frame assembly attached to the bottom cover. The illustrated embodiment avoids welds on the coke drum, does not stress the coke drum with additional weight and will operate in low-clearance environments.

10 [0024] Fig. 1 shows a side view of an unheading device 1 according to a preferred embodiment. As illustrated, a coke drum 100 is supported by a support structure 130, and is tightly sealed by a bottom cover 110 that is secured in place by bolts 112. The bottom cover 110 is tightly sealed as illustrated during a coking process. The bolts 112 securing the bottom cover 110 may be locked and unlocked hydraulically, as disclosed in U.S.

15 Patent No. 6,223,925, which is hereby incorporated by reference.

[0025] Fig. 2 shows two vertical actuators 200, 210 and one rotating actuator 220.

Vertical actuators 200, 210 are attached to the support structure 130 and the bottom cover 110 by way of dual pivots 232, 234 (see Fig. 3). The dual pivots 232, 234 allow the vertical actuators 200, 210 to rotate about two orthogonal axes and may be of any type
20 known in the art, such as ball joints or U-joints, but preferably they are U-joints. Vertical actuators 200, 210 are also able to move axially, as is known in the art.

[0026] Although a single rotating actuator **220** is illustrated, two or more may be provided with only minor modification to the invention as illustrated. In addition, although two vertical actuators **200**, **210** are shown, one or more than two may be provided. Each actuator may be any type adapted to move the bottom cover **110**, including but not limited to a hydraulic cylinder, a screw and follower, or a cable set.

[0027] According to the preferred embodiment, a single rotating actuator **220** is attached at a support end to the support structure **130** by way of a pivot **222**. A cover end of the rotating actuator **220** is attached to a connecting plate **226** by way of a pivot **224**. The connecting plate **226** is attached to the bottom cover **110** by any one of a number of ways, such as welding. A frame assembly **300** is also pivotally attached to the connecting plate **226**, preferably in the same place as rotating actuator **220**. Of course, the frame assembly **300** and the rotating actuator **220** may be attached to the bottom cover **110** in different places. Although three connecting plates **226** are illustrated, more or fewer than three may be provided. Furthermore, the connecting plate **226** may be left out as illustrated in Fig.

1A, which shows the rotating actuator **220** and the frame assembly **300** attached directly to the bottom cover **110**.

[0028] The frame assembly **300** is preferably comprised of a plurality of rigid members. As illustrated in Fig. 2, the frame assembly **300** includes two opposing lower members **312**, **314** joined by a bottom cross member **332** and a middle cross member **334**. Two opposing upper members **322**, **324** are joined by the middle cross member **334** and a top cross member **336**. As best seen in Fig. 1, the upper opposing members **322**, **324** project from the lower opposing members **312**, **314** in different planes. However, the design of

the frame assembly is not limited to the configuration shown, and may be any one of a number of strong, rigid configurations, including but not limited to an H configuration or a single truss. Moreover, the frame assembly may be curved, or have additional lattice work for support, rather than having the bent appearance illustrated in Fig. 2.

- 5 **[0029]** The frame assembly **300** is connected at its sliding end to a sliding floor attachment assembly **400**. In the illustrated embodiment, two sliding floor attachment assemblies **400** are shown, but any number may be provided. As illustrated in Figs. 6 and 7, the floor attachment assembly **400** is preferably comprised of an anchor **410** having a pair of side covers **412**, **414**, a slide block **420**, an actuator **430** having a rod **434** connected to a rod clevis **432**, and a pin **436**. The anchor **410** is secured to the floor by a plurality of bolts and the actuator **430** is secured to the anchor **410**. The pin **436** is long enough to interconnect the sliding end of frame assembly **300**, the rod clevis **432** and the slide block **420**. The slide block **420** slides in a rectangular aperture in the side covers **412**, **414** of anchor **410** to ensure secure, smooth movement of the sliding end of the frame assembly **300** when moved by the actuator **430**.
- 10
15

- [0030]** Referring now to Figs. 1 and 3-5, the unheading process of a preferred embodiment of the invention will be explained. Initially, the cover **110** is tightly closed during the coking process. After coking, the cover **110** is preferably removed in only a vertically downwards direction until the bolts **112** have been cleared, as shown in Fig. 3. Of course, the cover **110** need not be lowered only vertically -- it is possible to simultaneously rotate and lift the cover **110**.
- 20

[0031] To allow the cover **110** to move vertically downwards, the sliding end of the rigid frame assembly **300** must be moved in direction **W** by the floor actuator **430**. In addition, the vertical actuators **200, 210** not only move axially, but also rotate in direction **X** about the pivot **232**, shown in Fig. 5. Next, as Fig. 4 shows, the cover **110** is simultaneously lifted and rotated. To accomplish the simultaneous lifting and rotation, the rotating actuator **220** is contracted, causing rigid frame assembly **300** to rotate in direction **Y**, defining an arcuate path, and the vertical actuators **200, 210** to rotate in direction **Z**. In addition, the vertical actuators **200, 210** may be extended to further rotate the cover **110**, although it is not necessary.

[0032] As can be appreciated from the figures and the foregoing description, the bottom cover **110** is always attached to the support structure **130** (through the vertical actuators **200, 210** and rotating actuator **220**) and the floor (through the frame assembly **300** and the floor attachment assembly **400**). Thus, the bottom cover is always securely held, preventing swaying or misalignment of the bottom cover. In addition, none of the components are welded to the coke drum. As a result, there are no welds subject to the strength-deteriorating effects of the hot coke drum, and maintenance costs are reduced. Furthermore, since the apparatus is not supported by the drum, there is no unnecessary stress on the drum.

[0033] While the present invention has been described with respect to what is at present considered to be the preferred embodiments, it should be understood that the invention is not limited to the disclosed embodiments. To the contrary, as exemplified above, the invention is intended to cover various modifications and equivalent arrangements included

within the spirit and scope of the appended claims. Therefore, the scope of the following claims is intended to be accorded the broadest reasonable interpretations so as to encompass all such modifications and equivalent structures and functions.